Rocky Mountain Rail Authority High Speed Rail Feasibility Study Summary 9/16/10

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The RMRA High Speed Rail Feasibility Study for Colorado was completed earlier this year.

The 18 month feasibility study, conducted with significant financial and technical support from the Colorado Department of Transportation (CDOT), focused on determining whether options exist that are capable of meeting Federal Railroad Administration (FRA) technical, financial and economic criteria for high-speed rail feasibility.

The study considered a full range of technology options from conventional Amtrak service (with maximum speeds of 79 mph) through high-speed train and maglev technologies that have maximum speeds of up to 300 mph. It also evaluated a comprehensive set of routes including highway routes, existing and abandoned rail routes, and completely new Greenfield routes. General station locations were also evaluated based on potential market-demand and existing local planning efforts.

Combinations of technologies, routes and stations were analyzed and optimized through a dynamic evaluation process that focused on technical and economic feasibility. In addition, input was gathered from a steering committee comprised of technical and policy level representatives that met monthly and from teams of local agency stakeholders throughout both corridors that met at key study milestones.

Among the most critical FRA feasibility criteria for high-speed rail are:

• **Positive (>1.0) operating ratio** – This means that, unlike public highways and local transit systems, the project does not require any government subsidies to cover its cost of operation;

• **Positive (>1.0) cost - benefit ratio** – This means that for every dollar of capital and operating costs, the project creates economic benefits greater than one dollar.

The study identified a number of options between Fort Collins and Pueblo in the I - 25 corridor and Denver International Airport and Eagle County Airport in the I-70 corridor that exceed the FRA's threshold for high-speed rail feasibility.

The RMRA Feasibility Study developed a number of statewide options for Intercity Passenger Rail in Colorado based on a range of rail technologies in revenue service throughout the world. It also evaluated the operational and economic feasibility of these Intercity Passenger Rail options based on Federal Railroad Administration (FRA) criteria.

It did not accomplish the establishment of a preferred alignment, the establishment of a preferred technology, the establishment of preferred station locations or the evaluation of environmental impacts and determination of mitigation. These are all future NEPA Study

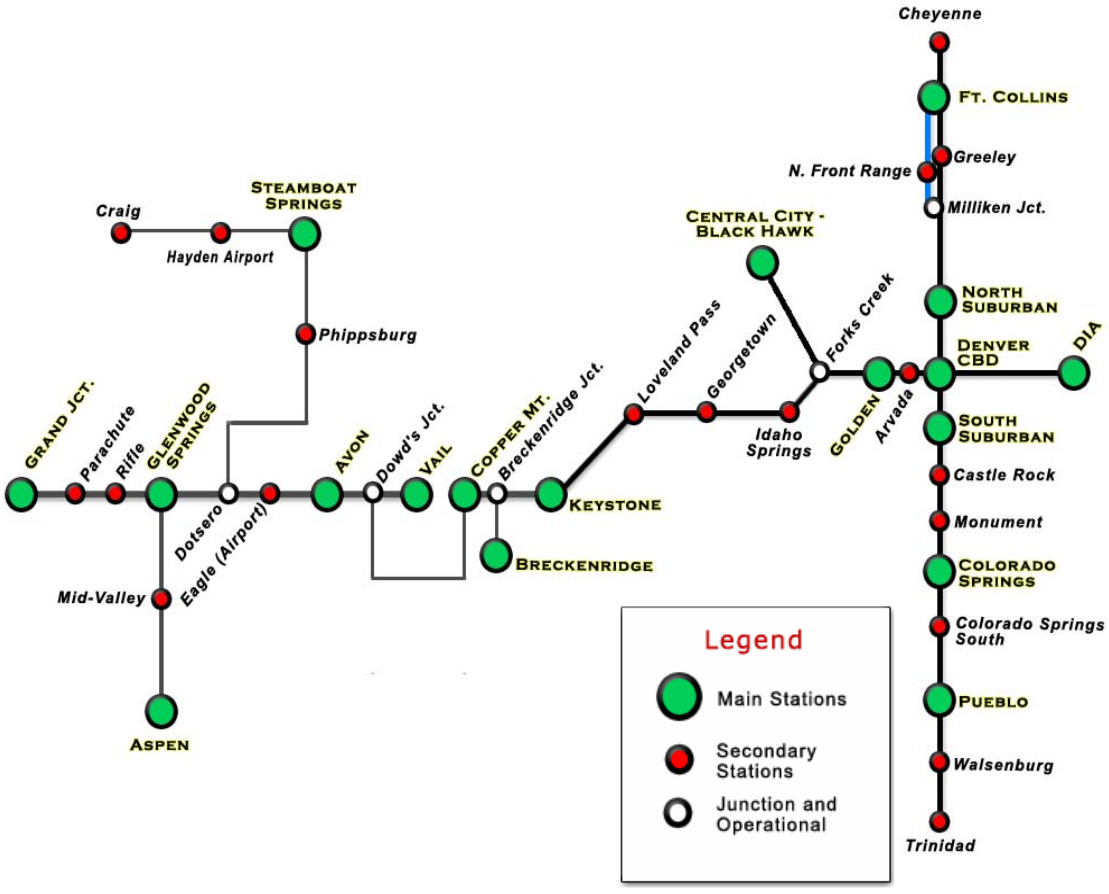
functions. It did however inform these future decisions by a fairly thorough evaluation of technologies, routes and station locations based on FRA feasibility criteria.

It is anticipated that the RMRA Study of statewide options for Intercity Passenger Rail in Colorado that meet the FRA criteria for operational and economic feasibility will influence the NEXT STEPS for High Speed Intercity Passenger Rail development in Colorado.

The following are the Alternative Groupings in terms of routes, technologies and station locations developed in the RMRA Study.

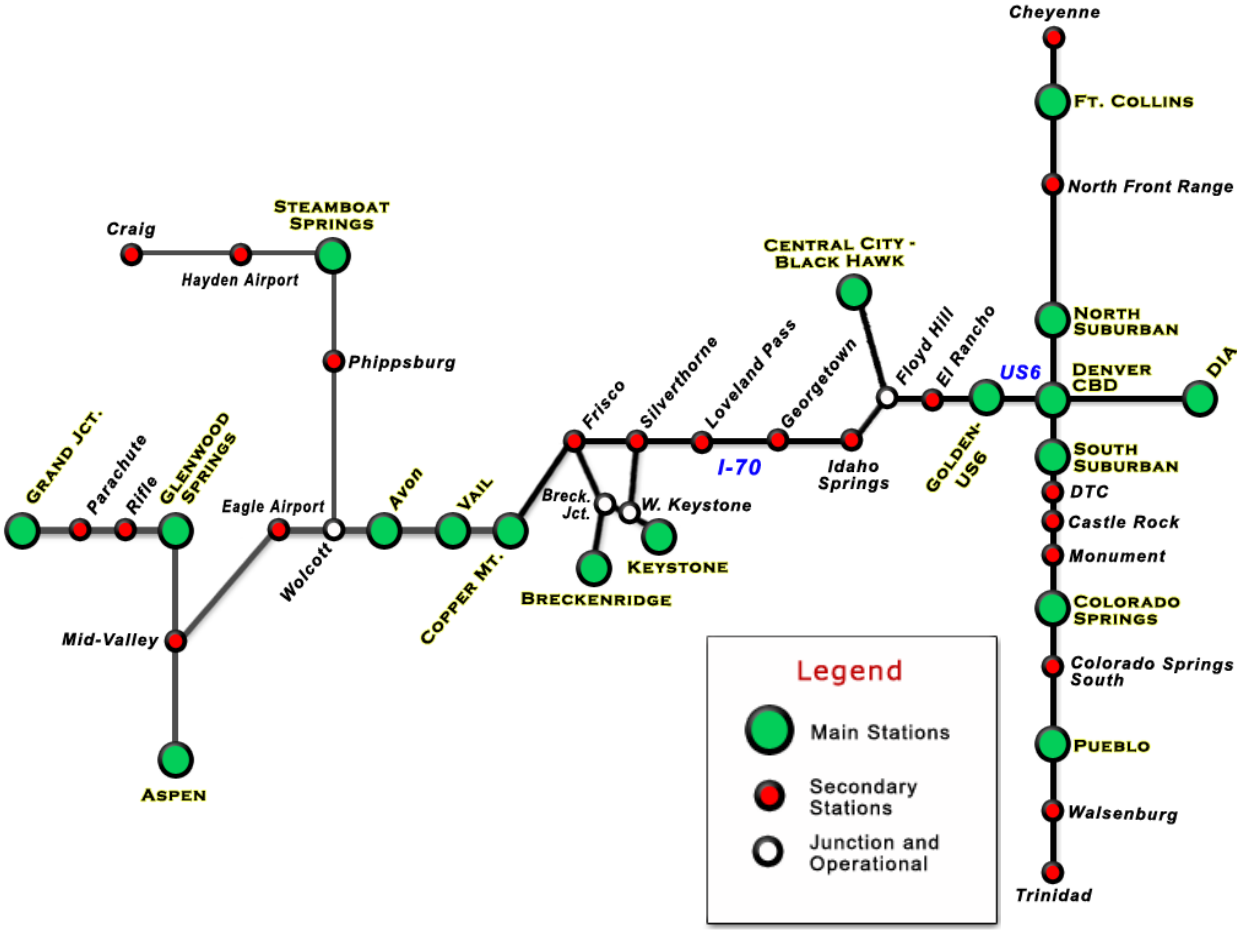
Alternative Grouping - 1

Conventional Rail Technologies in Front Range Freight Railroad Corridors and A New 4 Percent Grade Route Developed for the I-70 Mountain Corridor



Alternative Grouping - 2

Concept Vehicle: All Axles Powered, 220 mph, Tilting EMU and Low and High Speed Maglev for I-70 Mountain Corridor 7 Percent Grade Highway Alignment and I-25 Corridor Highway and Greenfield Route



RESULTS

Results are shown from a selected number of alternatives developed and evaluated in the RMRA study. For each alternative the following information is provided.

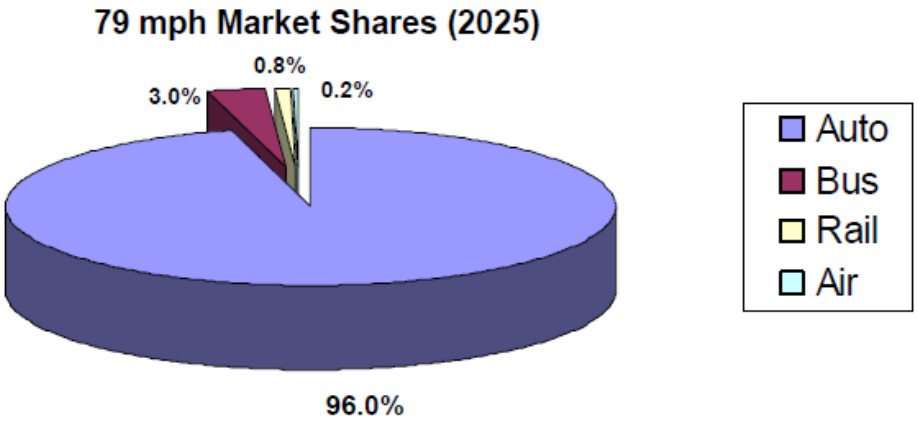
Projected Capital Cost based on 2008 dollars
Projected 2025 Market Share Ridership
Projected 2035 Market Share Ridership
FRA Operating Ratio
FRA Cost to Benefit Ratio
Conclusions

Conventional Amtrak Intercity Passenger Rail in Freight Railroad Corridors

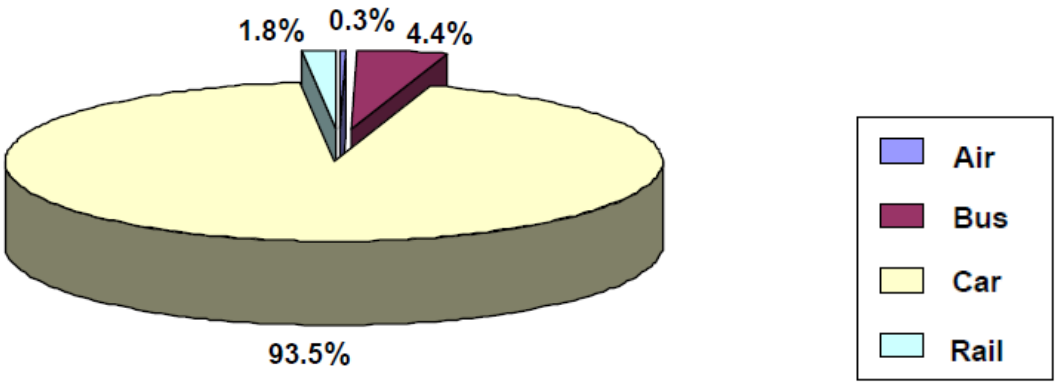
- **I-25 Corridor Only**
- **Existing Freight Railroad Alignment**
- **79 mph Rated Track**
- **79 mph top speed, Heavy Diesel Locomotive Hauled or DMU Technology**
- **Only 2 % to 3 % Grade Capable**
- **2025 Ridership Market Share of .8 percent**
- **2035 Ridership Market Share of 1.8 percent**
- **Operating Ratio = .64**
- **Cost to Benefit Ratio = .19**

This is the FRA National “High Speed” Intercity Passenger Rail Model for FRA Compliant passenger trains operating on or adjacent to Freight Railroad Tracks.

Ridership

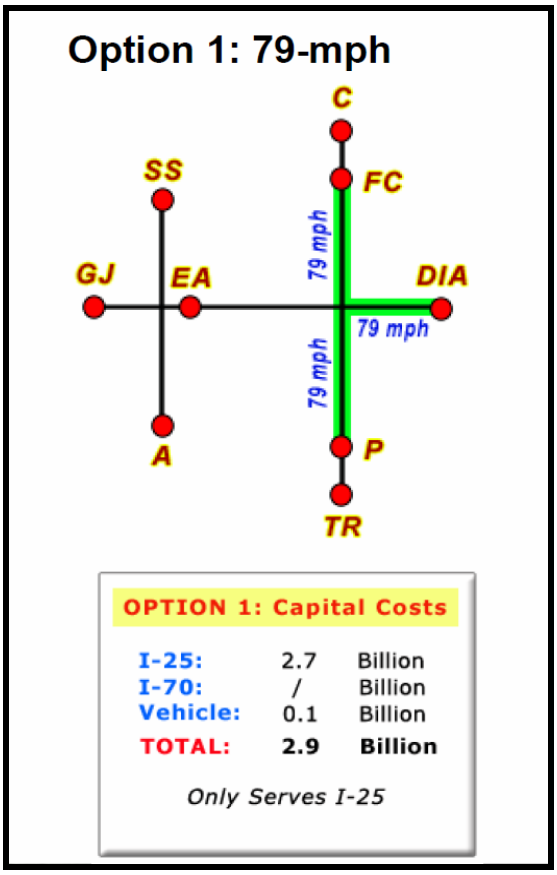


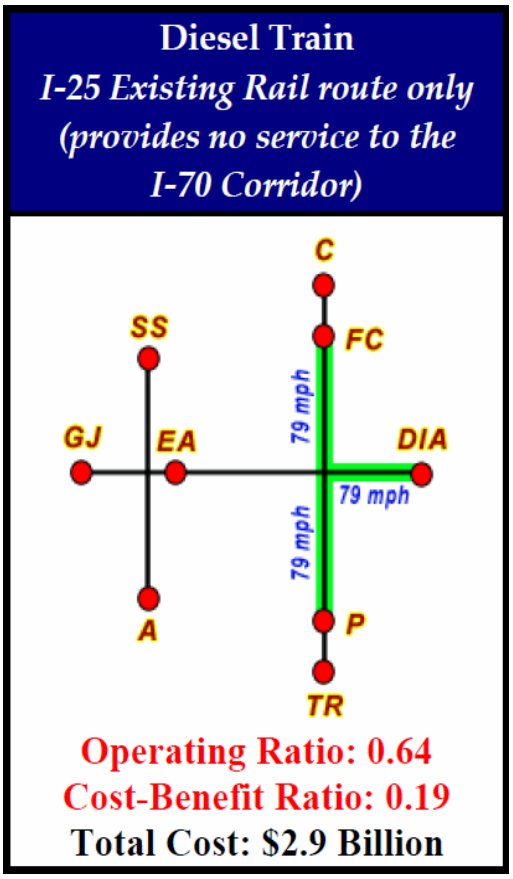
In 2025 with a Low Gas Price (from the Energy Information Administration) and the Central Demographic projections for Colorado, the Ridership Market Share as a percentage of overall intercity trips in the I-25 corridor is just .8 percent. This is lower than Intercity Bus which is projected to be 3 percent with this low-speed intercity passenger rail alternative.



In 2035 with Central Gas Prices (from the Energy Information Administration) the Ridership Market Share as a percentage of overall trips in the I-25 corridor is just 1.8 percent. This is lower than Intercity Bus which is projected to be 4.4 percent with this low-speed intercity passenger rail alternative.

System Termini & Capital Cost





Conclusion

This is an extremely poor performing intercity alternative with dismal results. Economic return on the capital investment by the state of Colorado would be 19 cents for every dollar invested. Worse still, this system would bring in only 64 cents in annual operating revenues for every dollar of annual operating costs, so it would require a fairly steep annual operating subsidy.

This passenger rail system would not even pull passengers from Intercity Bus, making Intercity Bus a more cost effective transit investment in the I-25 corridor. The RMRA study data confirms the problem with ridership and fare revenues for typical Amtrak 79 mph Intercity Passenger Rail service in Freight Railroad Corridors. With Front Range average speeds only in the 40 to 50 mph range, it is too slow and too inconvenient to pull market shares from the automobile or even from Intercity Bus. This alternative is a poor choice for transportation investment in the I-25 corridor and should be discouraged.

79 mph and 90 mph Conventional Heavy Diesel Intercity Passenger Rail

Low Speed, fare subsidized, poor performing 79 mph and 90 mph conventional diesel intercity passenger rail systems on shared freight railroad infrastructure with at-grade crossings that only produce average speeds in the 30 to 50 mph range, appear to be the priority for Intercity Passenger Rail Development in the United States by the Federal Railroad Administration today. This is the primary reason that High Speed Rail will never be successful in the United States under the direction of the FRA.

There must be a complete overhaul of FRA HSR policy and staff or the political will to move true 150 mph to 300 mph, safe, dedicated and completely grade separated guideway, electric high speed conventional rail and high speed maglev (with 90 mph or higher average speeds) out of the FRA's jurisdiction. True dedicated, completely grade separated guideway, safe, electric high speed conventional rail and high speed maglev will never be successful in the US until this occurs.

While low-speed commuter rail can be a competitive travel mode for relatively short distance commuter trips, this same travel mode fails miserably in the long distance intercity trip market because it is simply too slow to be competitive with driving and flying.

A 30 to 40 mph average speed commuter rail system may be competitive for ridership who's daily commuter trips are between 20 and 40 miles in one-way distance. This is because the average rider will spend less than an hour in each direction on the train which for a 20 to 40 mile one-way distance in urban areas is fairly competitive with bus and automobile travel.

However, this same model (30 to 40 mph average speed heavy diesel passenger rail service on freight railroad tracks) for trips of 100 to 600 miles produces very long travel times that are not generally competitive with intercity bus and automobile travel. For example, even a trip as short as 100 miles would take 2.5 hours by low-speed heavy passenger rail on freight railroad tracks. In Colorado, this would compare to about 2 hours by intercity bus and about one hour and 40 minutes by car.

The key point to remember is that the motivation behind the development of Intercity Passenger Rail alternatives in Colorado is not simply for the sake of providing an energy efficient or "Green" travel mode alternative to riding the bus, driving a car or flying on a commercial airline. It is to provide a very competitive travel mode that the state's residents and visitors will actually want to pay to ride and will choose to use in relatively high numbers! If this cannot be accomplished, then don't build it!

In the local and national HSR debate, this point is too often lost. No one is being forced to ride a HSR system. It must be very desirable with considerable convenience and time savings over other existing modes so that people will freely choose to ride it. Instead, FRA national intercity passenger rail policy through an ultra-regressive National Rail Plan and recent financial grant decisions, forces states to look primarily at low-speed, poor performing, fare subsidized intercity heavy rail systems on shared freight railroad infrastructure, that on a relative basis, no one will ride. This MUST change.

130 mph Tilting, Lightweight Diesel Passenger Rail

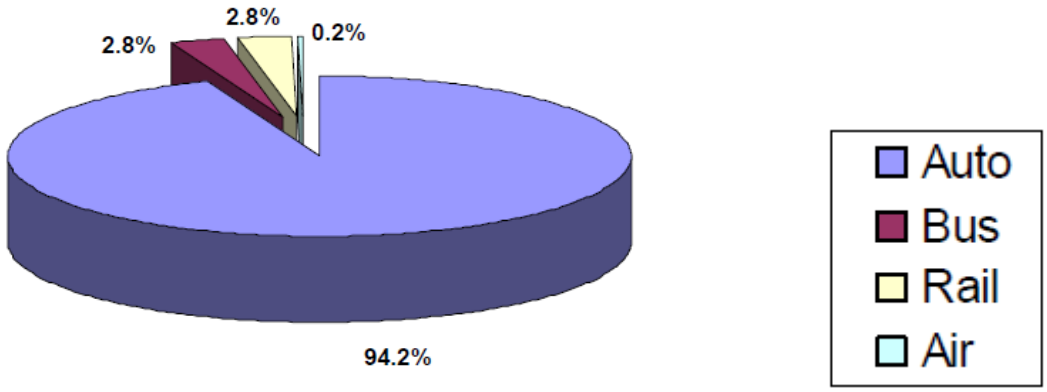
- **I-25 Corridor Only**
- **Existing Freight Railroad Alignment**
- **110 mph Rated Track**
- **130 mph top speed Lightweight, Tilting Diesel Technology**
- **Only 2 % to 3 % Grade Capable**
- **2025 Ridership Market Share of 2.8 percent**
- **2035 Ridership Market Share of 4.8 percent**
- **1.14 Operating Ratio**
- **1.04 Cost to Benefit Ratio**

This is not a typical 110 mph heavy diesel passenger rail technology as currently being pursued by the FRA and Amtrak in various HSR (Low Speed) Intercity Passenger Rail Corridors throughout the United States today. This is a faster, lighter, higher performance, tilting diesel technology with a 130 mph top speed that is currently NOT compliant with FRA regulations for operating in Freight Railroad rights of way.

It CANNOT be assumed that the performance results for this lightweight, higher performance, tilting, 130 mph, diesel technology are typical of other 110 mph non-tilting, Heavy Diesel Passenger Rail technologies (Locomotive Hauled or Diesel Multiple Unit) being considered in other HSR (Low Speed) Intercity Passenger Rail Corridors across the United States today. These other Heavy Diesel Passenger Rail technologies will have the same dismal intercity performance in Colorado as noted in the conventional Amtrak alternative above.

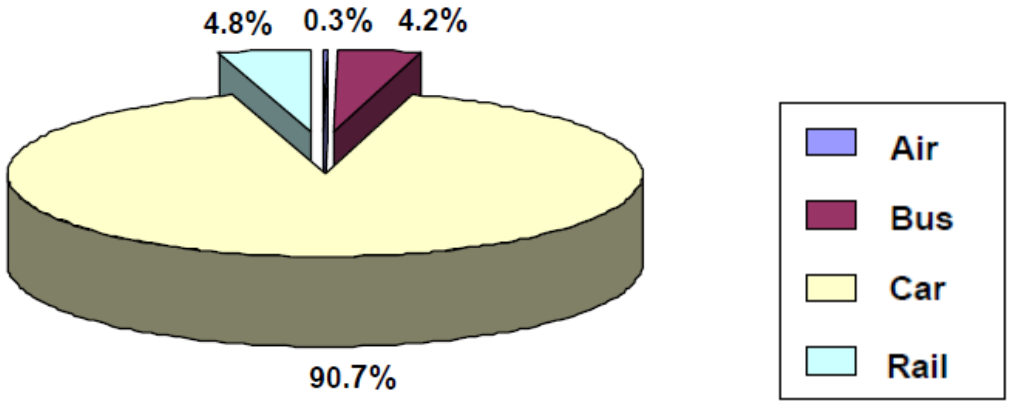
Ridership

130 mph Market Shares (2025)



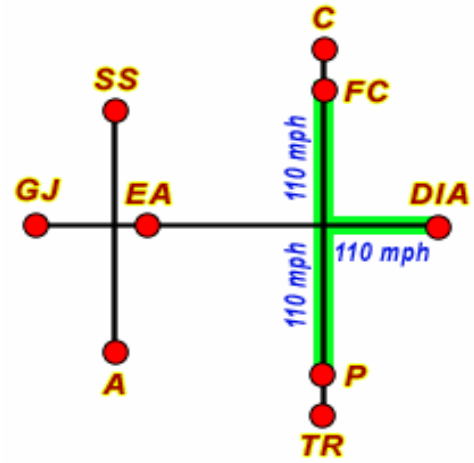
For the 130 mph, tilting, diesel technology, in 2025 with a Low Gas Price (from the Energy Information Administration) and the Central Demographic projections for Colorado, the Ridership Market Share as a percentage of overall intercity trips in the I-25 corridor is just 2.8 percent. This is exactly the same as Intercity Bus which is projected to be 2.8 percent with this intercity passenger rail alternative.

130 mph Market Shares (2035)



In 2035 with Central Gas Prices (from the Energy Information Administration) the Ridership Market Share as a percentage of overall trips in the I-25 corridor is just 4.8 percent. This is just slightly higher than Intercity Bus which is projected to be 4.2 percent with this intercity passenger rail alternative.

System Termini & Capital Cost

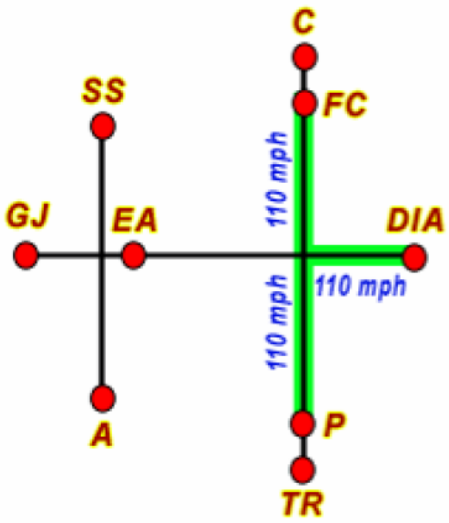


OPTION 2: Capital Costs

I-25:	2.7	Billion
I-70:	/	Billion
Vehicle:	0.2	Billion
TOTAL:	**2.9**	**Billion**

Only Serves I-25

High-Speed Diesel Train
*(I-25 Existing Rail Route Only)**
** Provides no service to the I-70 Corridor*



Operating Ratio: 1.14
Cost-Benefit Ratio: 1.04
Total Cost: $2.9 Billion

Conclusion

Front Range average speeds begin to exceed 70 mph with this 130 mph alternative which help it perform better in terms of ridership and fare revenues than the 79 mph Amtrak alternative.

Technology								
Description		79-mph Existing Rail Non tilting	110-mph Existing Rail Tilting	125-mph GF	150-mph ER Tilting	220-mph GF Non tilting	220-mph GF Tilting	300-mph GF
SUMMARY Denver - to - Trinidad	***Joint Line*** 210 mi	***4:30***	***2:55***	***2:17***	***2:40***	***2:05***	***2:00***	***1:45***
	Greenfield 231 mi	***47 mph***	***72 mph***	***101 mph***	***79 mph***	***111 mph***	***116 mph***	***132 mph***

Still, this is only a mediocre performing intercity alternative with fair results (operating ratio of 1.14 and cost to benefit ratio of 1.04). This alternative can barely pull passengers from intercity bus (Market Share equal to intercity bus in 2025 and just .6 percent ahead of intercity bus in 2035).

At least this 130 mph tilting diesel technology provides a marginal return on capital investment for the state of Colorado and a very modest operating profit. It can be considered as the "break even" alternative in the RMRA study. However, one might still make a fairly persuasive argument that it would be more cost effective to invest in Intercity Bus in the I-25 corridor.

150 mph Tilting, Lightweight Electric Passenger Rail

- **I-25 Corridor, Existing Freight Railroad Alignment**
- **110 mph Rated Track**
- **I-70 Mountain, New 4% Grade Alignment**
- **150 mph top speed Lightweight, Tilting Electric Locomotive Hauled w/2nd Car Assist Technology**
- **4% Grade Capable**
- **2025 Ridership Market Share of 8.6 percent**
- **2035 Ridership Market Share of 12 percent**
- **1.58 Operating Ratio**
- **1.02 Cost to Benefit Ratio**

This is the Eurostar Passenger Rail technology used to traverse the English Channel. For the grades descending and ascending the English Channel, this electric powered locomotive hauled train has a second car assist (front and back second car with drive axles) so it behaves more like an Electrical Multiple Unit (EMU) than a typical locomotive hauled train.

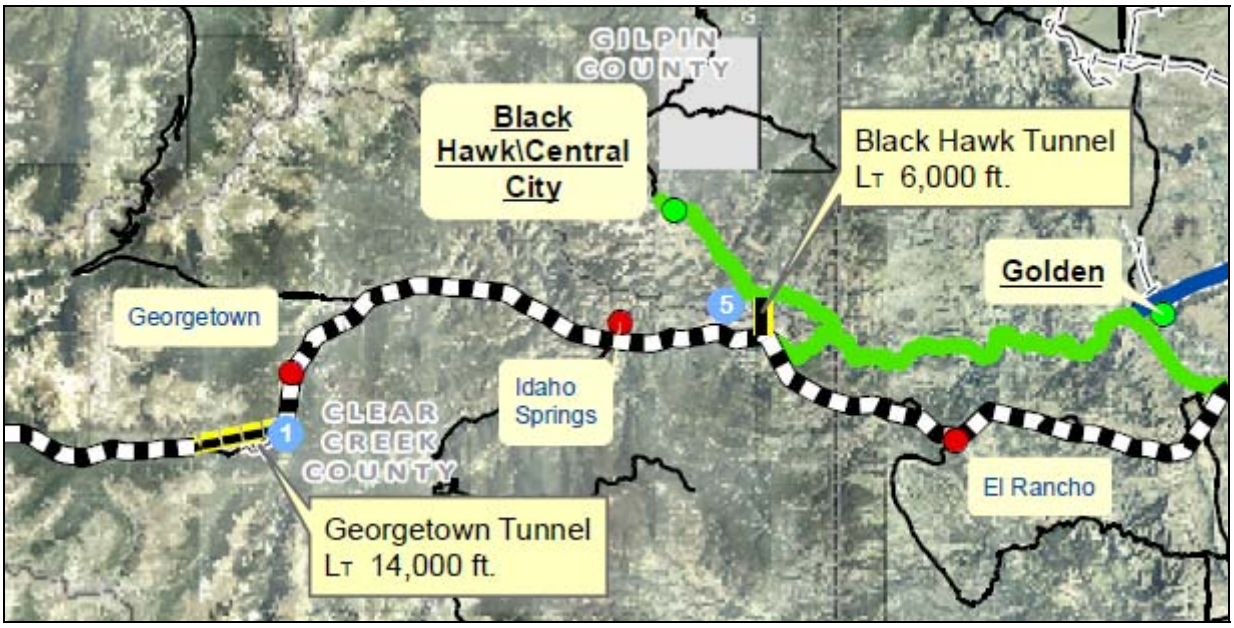
This technology is not currently FRA Compliant for running on or adjacent to Freight Railroad Track.

This is the first promising technology evaluated in the RMRA Study even though it is limited by a Freight Railroad route in the I-25 corridor and a four percent grade route in the I-70 mountain corridor.

An I-25 highway and Greenfield alignment will produce better travel times, better access to popular destinations and better ridership and revenue numbers than a freight railroad alignment due to improved station locations and less guideway curvature. A four percent

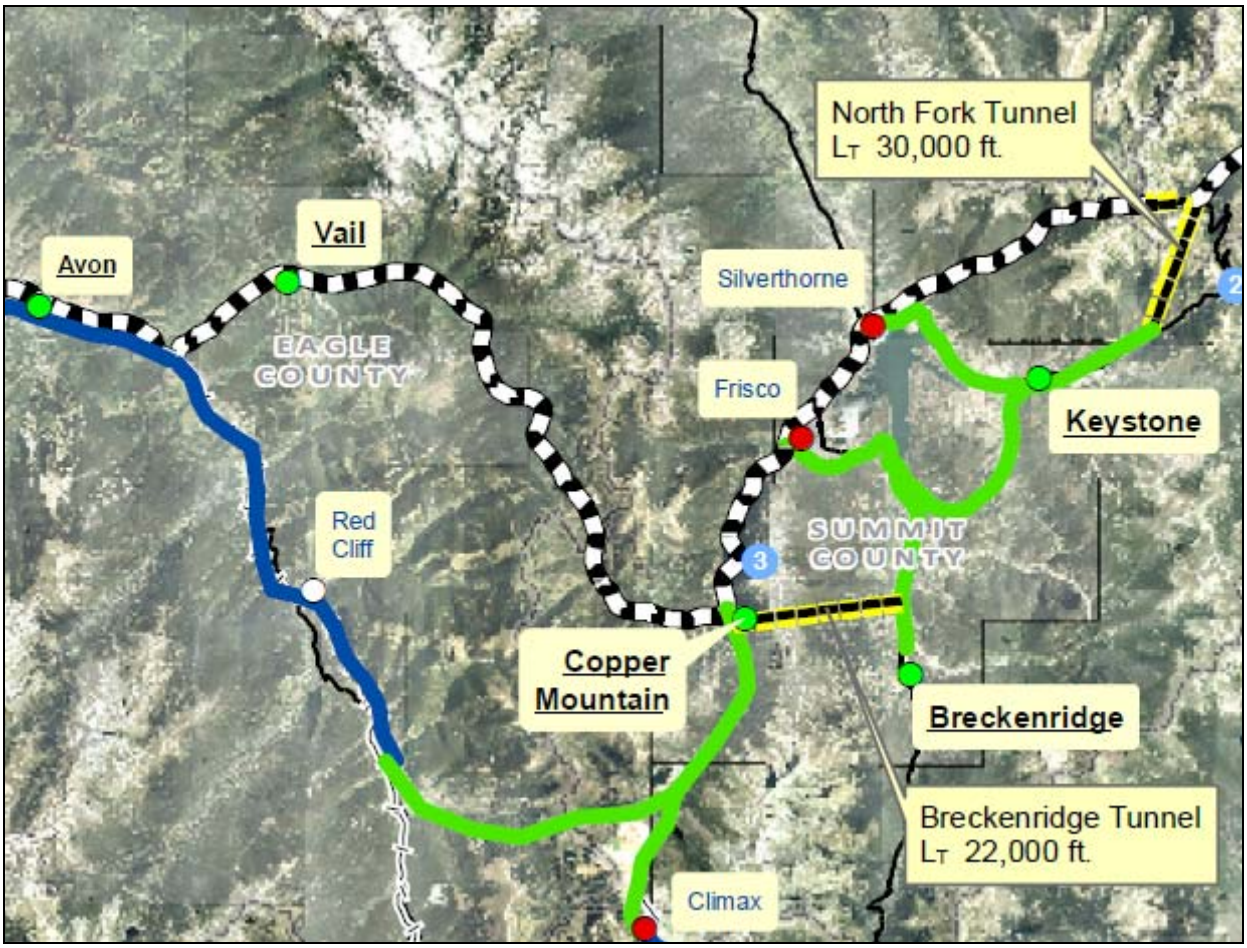
grade alignment in the I-70 mountain corridor will also be a significant challenge in any subsequent environmental clearance process. But at least this technology is capable of operating in a four percent grade environment which in theory could allow it to operate in the I-70 mountain corridor in a new alignment.

A theoretical example of a four percent grade mountain corridor route was developed for this technology in the RMRA Study. It included an alignment section completely separate from the I-70 highway corridor from Golden to the Hidden Valley area just east of Idaho Springs. This alignment section used the US 6 Clear Creek Canyon Corridor with several new tunnels from Golden to the Hidden Valley area just east of Idaho Springs. The four percent grade alignment also included a 14,000 ft tunnel north of the I-70 highway alignment in the area from Georgetown to west of Silver Plume to minimize the Georgetown Hill grade.



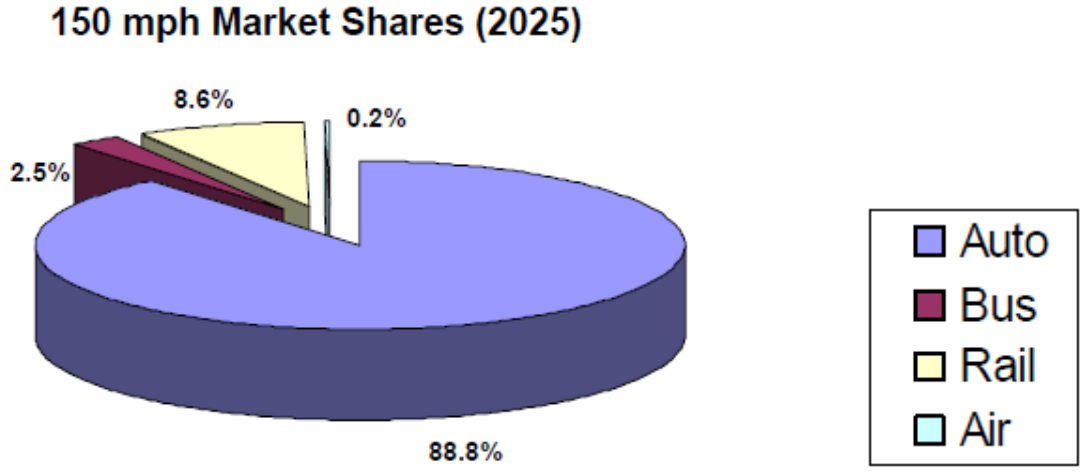
A new 30,000 ft tunnel was also included in the area of the Loveland Valley Ski Area that traverses the Continental Divide underneath Loveland Pass and emerges near US 6 about halfway between Arapahoe Basin and Keystone. A number of alignment options were developed from Keystone to rejoin the I-70 highway corridor in Silverthorne, Frisco and Copper Mountain, including a 22,000 ft tunnel south of the Town of Breckenridge connecting Breckenridge to Copper Mountain.

A major new alignment section was developed to connect Copper Mountain to Minturn and avoid the steep grades in the Vail Pass area of the I-70 highway corridor. This alignment section travels south along State Highway 91 to the Climax Reclamation area and then traverses west to join highway 24 in the area of Pando/Camp Hale. It then travels through Red Cliff and uses the Tennessee Pass freight railroad alignment to connect to Minturn. This alignment would not include a station in the Town of Vail.



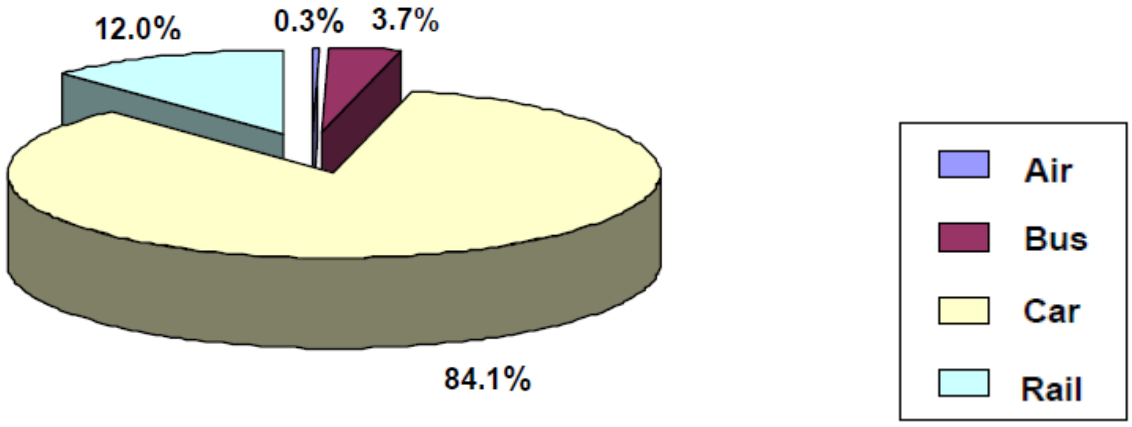
Ridership

For the 150 mph, tilting, electric technology, in 2025 with a Low Gas Price (from the Energy Information Administration) and the Central Demographic projections for Colorado, the Ridership Market Share as a percentage of overall intercity trips in both the I-25 and I-70 corridors is 8.6 percent. This is well above Intercity Bus which is projected to be 2.5 percent with this intercity passenger rail alternative.

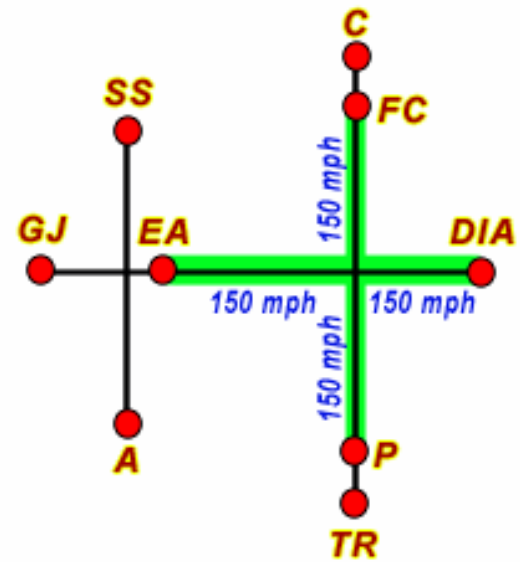


In 2035 with Central Gas Prices (from the Energy Information Administration) the Ridership Market Share as a percentage of overall trips in both the I-25 and I-70 corridors is 12 percent. This is much higher than Intercity Bus which is projected to be 3.7 percent with this intercity passenger rail alternative.

150 mph Market Shares (2035)



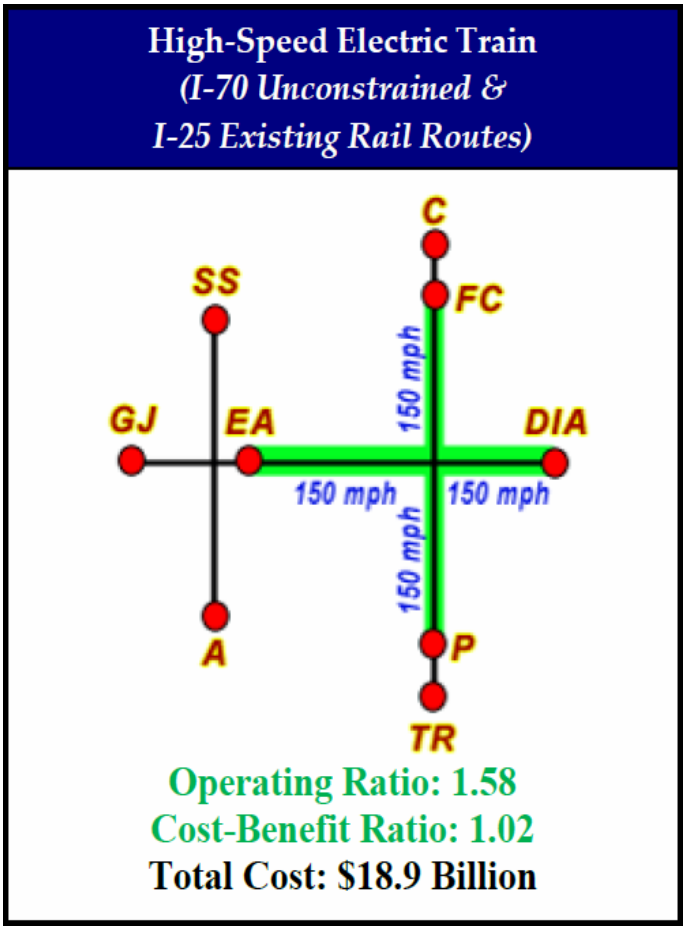
System Termini & Capital Cost



OPTION 4: Capital Costs

I-25:	2.9	Billion
I-70:	15.6	Billion
Vehicle:	0.4	Billion
TOTAL:	**18.9**	**Billion**

No Service West of Eagle County Airport



Conclusion

This is an interesting alternative because it demonstrates significantly higher Ridership Market Share numbers when the I-25 corridor is combined with the I-70 corridor. In addition, average speeds for this technology begin to exceed highway speeds which is a critical lesson learned in this study. In order for intercity passenger rail to compete with the automobile, it must be faster and at least as convenient. The 150 mph tilting electric technology begins to accomplish this as can be seen in the I-25 chart below. It would do even better in an I-25 highway and Greenfield alignment in terms of both speed and ridership.

Technology								
Description		79-mph Existing Rail Non tilting	110-mph Existing Rail Tilting	125-mph GF	150-mph ER Tilting	220-mph GF Non tilting	220-mph GF Tilting	300-mph GF
SUMMARY Cheyenne - to - Denver	***Best Combo*** 114 mi	***2:05*** *55 mph*	***1:27*** *79 mph*	***1:15*** *91 mph*	***1:15*** *91 mph*	***1:13*** *94 mph*	***1:07*** *102 mph*	***1:03*** *107 mph*

The downside of this alternative is that it still requires a 4 percent grade alignment in the I-70 mountain corridor. This is a substantially longer alignment in the I-70 mountain corridor than the highway alignment. In addition, this alignment does not include a station stop in Vail which could be argued to be one of the largest intercity trip attractors in the mountain corridor.

A great deal of the proposed 4 percent grade alignment will traverse US Forest Service lands, Roadless Areas, Federally protected Section 4 (f) lands, County Open Space lands and even EPA Superfund areas. When comparing the environmental impacts in further National Environmental Protection Agency (NEPA) regulated studies, there will be far greater impact associated with a brand new alignment than with an I-70 highway alignment. It is very unlikely that a brand new alignment would be selected as a preferred alternative in a subsequent NEPA study.

In addition, development in the mountain corridor has followed the highway corridor for the past 50 years and that development has created the major trip attractors in the corridor (recreation, lodging, camping, historic, landmark and other scenic destinations, casinos, hot springs and winter and summer resort towns). So, in other words, the highway corridor is already disturbed and developed, and contains the destinations that people want to visit. Any new transportation capacity in the corridor will need to follow the current highway alignment for the most part, because it is where people want to go and where less environmental disturbance will occur.

Concept Vehicle:
7 % Grade Capable, All Axles Powered, 220 mph, Tilting EMU

- **I-25, Highway Alignment & Greenfield**
- **220 mph Rated Track**
- **1-70 Mountain, 7% Grade Highway R.O.W. Alignment**
- **220 mph top speed Lightweight, Tilting Electric (EMU) Technology**
- **7% Grade Capable with Electric Locomotives Front and Back**
- **2025 Ridership Market Share of 11.3 percent**
- **2035 Ridership Market Share of 16 percent**
- **1.84 Operating Ratio**
- **1.28 Cost to Benefit Ratio**

This is a concept technology developed from very high speed (220 mph) Electrical Multiple Unit (EMU) trains operating today in Europe and Asia. For this technology a Highway Corridor and Greenfield Alignment with some short segments Adjacent to Freight Railroad Tracks through Metro Denver was assumed. This technology is not currently FRA compliant for running on or adjacent to Freight Railroad Track.

The initial concept for this technology was an all axles powered version of a 220 mph, tilting, Siemens ICE 3 EMU. However, it was eventually determined that Siemens and other major passenger rail vehicle manufacturers throughout the world might not necessarily build an all axles powered version of their popular very high speed, 220 mph, tilting EMU train-

set specifically for Colorado. This would need to be a train-set capable of operating on seven percent grades and also at 220 mph in lower grade environments such as in the I-25 corridor.

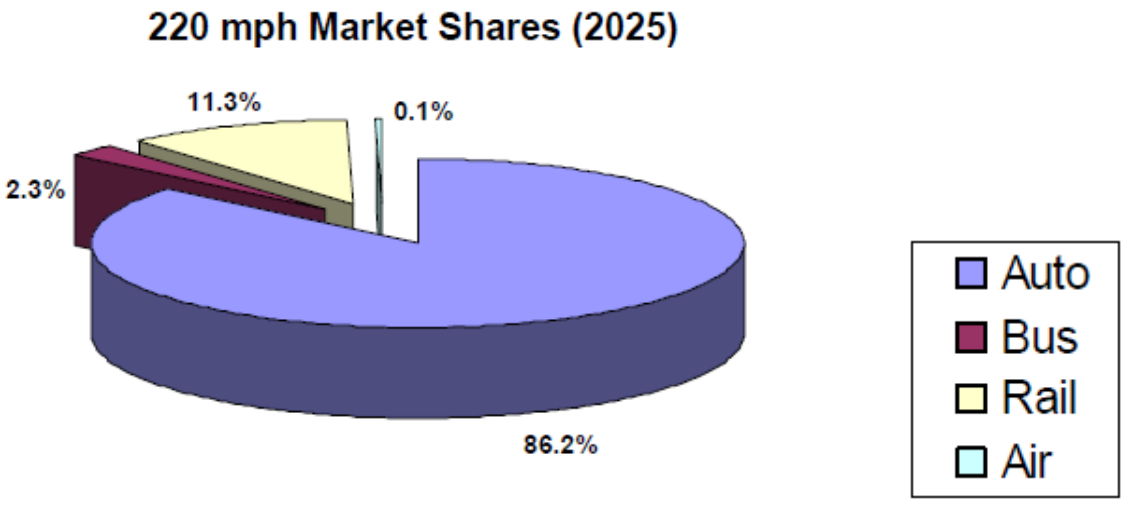
Standard very high-speed, 220 mph, tilting EMU train-sets are sold throughout the world for operation in dedicated passenger rail guideways with a maximum grade of only 2 percent. There are multiple drive axles on these train-sets, but not all axles are powered. An all axles powered version of a typical 220 mph, tilting EMU would require completely new electrical and drive systems, effectively making it an entirely new train-set. The time and investment to develop this new train-set might take years and not be recoverable through limited Colorado based sales. As a result, such a train-set may never be developed.

It was assumed that specifying a standard Siemens 220 mph, tilting, ICE 3 EMU (or the equivalent) for this technology class would be sufficient for the bulk of the Colorado system. Helper electric locomotives (front and back) would be used for the 7 percent grade segments in the I-70 mountain corridor.

Eventually in pursuing the Federal Railroad Developed alternative in the RMRA study, any sustained seven percent grade sections of an alignment were discarded for all conventional passenger rail vehicles due to the extra capital and maintenance expense and the logistics of operating the helper locomotives. As a result, the conclusions reached for this specific technology class in a seven percent grade highway alignment are speculative at best and at worst, considerably misleading.

In effect, this alternative (a standard very high-speed, 220 mph, tilting EMU) has the same environmental negatives as the 150 mph electric, tilting, passenger rail technology because it essentially requires a four percent grade alignment in the I-70 mountain corridor. However, it is faster and would provide superior travel times to the 150 mph electric rail technology. This allows it to outperform the 150 mph electric rail technology in both 2025 and 2035 ridership.

Ridership

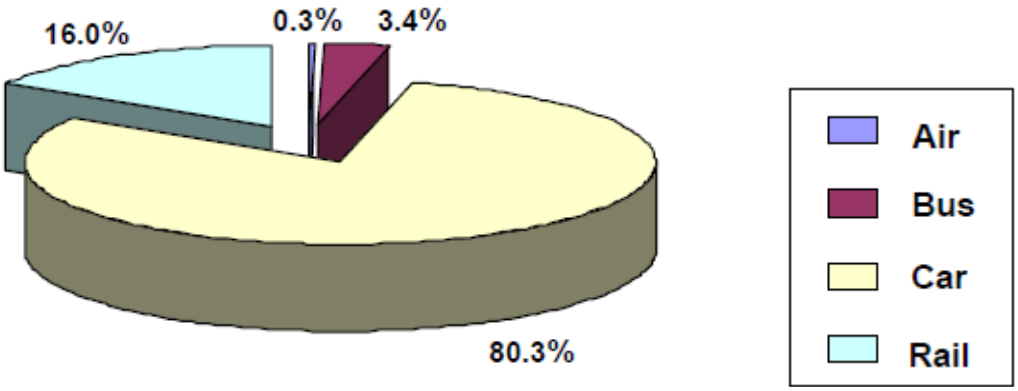


For the 220 mph, tilting, electric technology, in 2025 with a Low Gas Price (from the Energy Information Administration) and the Central Demographic projections for Colorado, the Ridership Market Share as a percentage of overall intercity trips in both the I-25 and I-70

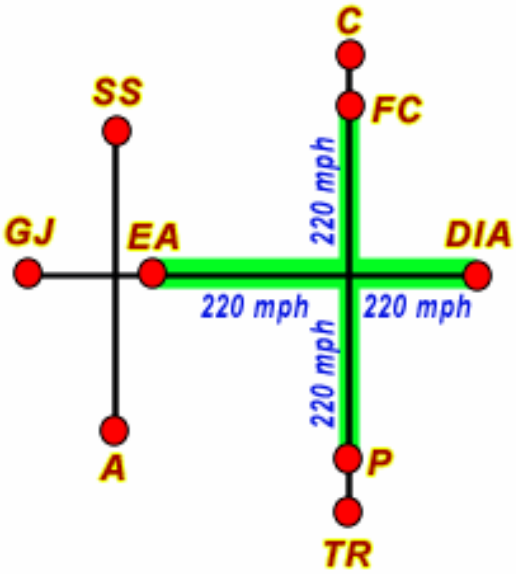
corridors is 11.3 percent. This is well above Intercity Bus which is projected to be 2.3 percent with this intercity passenger rail alternative.

In 2035 with Central Gas Prices (from the Energy Information Administration) the Ridership Market Share as a percentage of overall trips in both the I-25 and I-70 corridors is 16 percent. This is much higher than Intercity Bus which is projected to be 3.4 percent with this intercity passenger rail alternative.

220 mph Market Shares (2035)



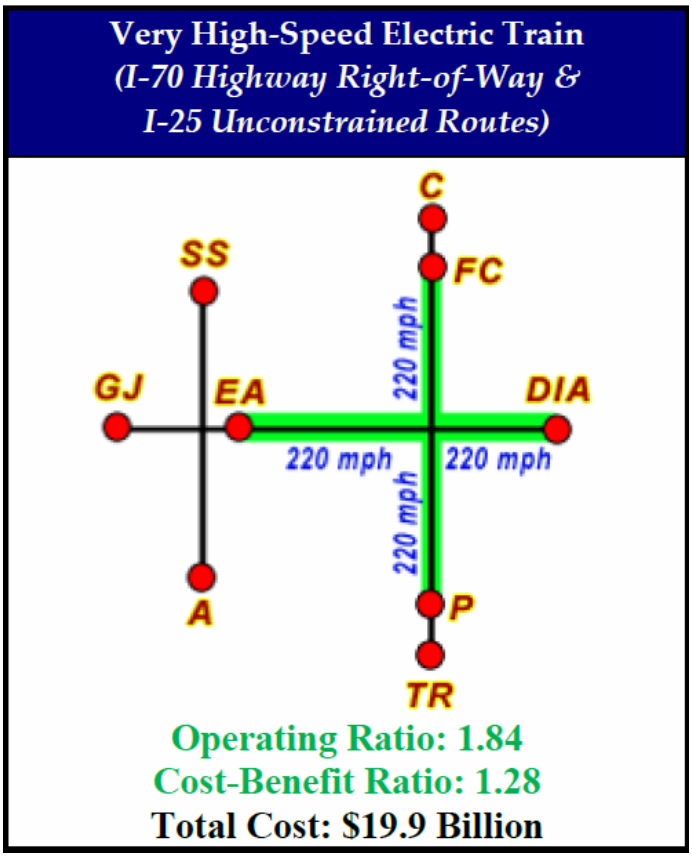
System Termini & Capital Cost



OPTION 5: Capital Costs

I-25:	6.0	Billion
I-70:	13.3	Billion
Vehicle:	0.6	Billion
TOTAL:	**19.9**	**Billion**

No Service West of Eagle County Airport



Conclusion

The value of the analysis for the 220 mph, tilting, EMU technology is in the advantage of a Highway/Greenfield alignment in the I-25 corridor over a freight railroad alignment. The Highway/Greenfield alignment produces less curvature and improved station locations which increases average speed and ridership over a freight railroad alignment.

Since Colorado like most of the United States has grown along highway corridors over the past 50 years, highway corridor destinations (business, commercial, industrial, office, recreational, residential, cultural and entertainment) drive intercity travel. Compared to existing freight railroad alignments, a highway corridor alignment provides better station locations for accessing the Denver Technology Center south of Denver, better access both north and south to the Denver International Airport, better access to the Fort Collins, Loveland and Greeley areas, and better access to the resort areas in the mountain corridor.

The 220 mph technology is also faster than the 150 mph electric rail technology and provides superior travel times as a result. This will increase ridership and generate higher fare revenues which provide better operating ratio and cost to benefit ratio numbers. So overall this alternative has very positive results in the I-25 corridor.

The flawed assumption in this alternative is that the 220 mph EMU technology can be both a 2 to 3 percent grade, 220 mph technology and a seven percent grade capable technology. In reality, it can't do both. An all axles powered version of this train-set to make it capable of operation in a 7 percent grade environment is strictly a philosophical concept and NOT a

reality at this point in time. There is no guarantee that such a vehicle will ever be developed.

In addition, the extra capital cost and maintenance expense along with the challenging logistics and travel delays associated with the operation of helper locomotives, would make the helper locomotive concept for a 7 percent grade alignment, also very unlikely. As a result, it is very likely that the 220 mph, tilting EMU technology will suffer from the requirement to operate in a four percent grade alignment in the I-70 mountain corridor which is substantially longer than the highway alignment and likely to have far greater environmental impacts. It also omits a critical station location in the Town of Vail.

The chart below is provided to demonstrate the travel times from DIA to Minturn for the 220 mph EMU technology in a 4 percent grade alignment. For comparison sake, a 7 percent grade capable maglev technology is shown in an I-70 highway right of way alignment.

It should be noted that if a proper alignment was developed for a 7 percent grade capable maglev technology that allowed for the elevated guideway to occasionally trespass outside the highway right of way to extend curve distances, the maglev speeds would be significantly higher and travel times significantly shorter. However, the example is a valid comparison to demonstrate the time and speed penalties associated with the 4 percent grade alignment in the mountain corridor.

The I-70 highway right of way Maglev travel time from DIA to Vail is 25 minutes shorter than the 220 mph EMU travel time from DIA to Minturn. In addition, a Vail passenger riding on the 220 mph EMU would still need to get from Minturn to Vail which could take another 10 to 15 minutes via shuttle including the transfer time.

Comparison of I-70 Corridor Express Travel Times between DIA and Minturn

Corridor Segment	220 mph Tilting EMU 4 % Unconstrained	300 mph Maglev 7 % Highway Alignment
DIA to Denver	12 min. 23 miles 115 mph	12 min. 23 miles 115 mph
Denver to Golden	10 min. 12 miles 72 mph	9 min. 12 miles 80 mph
Golden to Floyd Hill	25 min. 17 miles 41 mph	23 min. 17 miles 44 mph
Floyd Hill to Loveland Pass	23 min. 29 miles 76 mph	21 min. 28 miles 80 mph
Loveland Pass to Copper Mtn	24 min. 22 miles 55 mph	22 min. 22 miles 60 mph
Copper Mountain to Vail	N/A	14 min. 18 miles 77 mph
Copper Mtn to Minturn	32 min. 34 miles 64 mph	19 min. 23 miles 73 mph
TOTAL: DIA to Vail	N/A	1 hr. 41 min. 120 miles 71 mph
TOTAL: DIA to Minturn	2 hr. 6 min. 137 miles 65 mph	1 hr. 46 min. 125 miles 71 mph

300 mph Maglev Ultra High Speed Electric Technology

- **I-25, Highway Alignment & Greenfield**
- **Completely Elevated, Grade Separated, Dedicated Guideway**
- **10 Percent Grade Capable**
- **300 mph Top Speed**
- **1-70 Mountain Corridor, 7% Grade Highway R.O.W. Alignment**
- **2025 Ridership Market Share of 12.8 percent**
- **2035 Ridership Market Share of 17.5 percent**
- **2.44 Operating Ratio**
- **.86 Cost to Benefit Ratio**

This is an existing magnetic levitation technology in revenue producing service in Shanghai, China. It is 10 percent grade capable with a top speed of 300 mph.

The 300 mph ultra high-speed maglev alternative produces the best average speeds, travel times, ridership and fare revenues of all alternatives evaluated in the RMRA study. It also produces the best operating ratio of all alternatives evaluated in the RMRA study generating $2.44 in fare revenues for every dollar of operational expense.

As a relatively light magnetically elevated vehicle driven by linear electric motors in the guideway, it does not rely on steel wheel on steel rail friction for propulsion and braking.

Instead the linear electric drive motors provide superior propulsion and braking performance (acceleration and deceleration) over conventional high-speed rail vehicles. With no moving wheels to lose traction on rails, it also has superior all weather operational capabilities to conventional high-speed rail vehicles. And since the maglev system does not rely on wheel on rail friction for propulsion and braking, it has lower operational and maintenance costs because there are no steel wheels and steel rails to wear out. Conventional high-speed rail

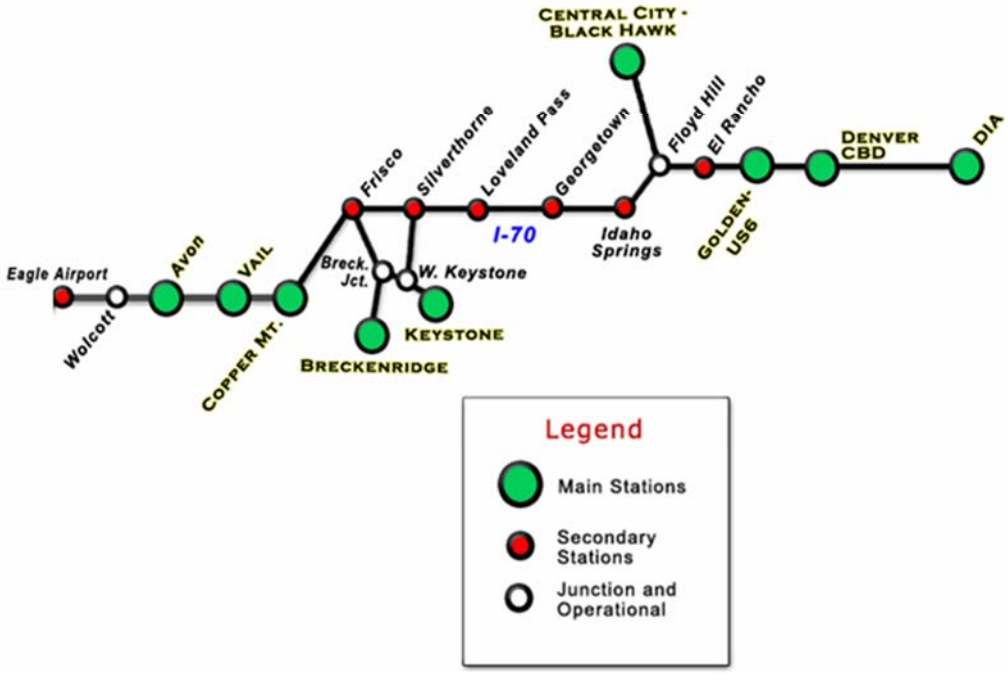
systems involve daily maintenance of the steel wheel and steel rails due to the constant and fairly intense friction produced in daily operation.

The 300 mph ultra high-speed maglev vehicle operates on a completely elevated guideway system. It is the safest mode possible with zero potential conflicts with freight trains or any other vehicles on roadways or water bodies. Since it is a completely elevated, electric powered system with no steel wheel on steel rail friction, it has much lower environmental impacts than conventional at-grade passenger rail systems (less noise, minimal intrusion on wetlands and water bodies, minimal impact on wildlife, minimal impact on communities and zero conflict with freight trains, cars and trucks).

The 300 mph ultra high-speed maglev alternative is the only viable alternative evaluated in the RMRA study that could operate in an I-70 mountain corridor highway alignment and is in revenue producing service somewhere in the world today. It is also the only RMRA alternative consistent with the Advanced Guideway System alternative selected as the transit component of the preferred alternative in the Federal Highway Administration's I-70 Mountain Corridor Revised Draft Programmatic Environmental Impact Statement which has just been released (September 2010).

In the complete I-70 corridor from DIA to the Eagle County Airport, the 300 mph ultra high-speed maglev alternative is identical in capital cost to an elevated conventional HSR system in the 4 percent grade alignment ($15.6 billion). It is understood that for any fixed guideway transit or high-speed rail system in the I-70 mountain corridor there will be a significant amount of structuring and tunneling because of the many narrow canyons in the corridor. The cost of constructing any passenger rail technology in the mountain corridor will be relatively high compared to typical at-grade construction in low grade environments.

300 mph Ultra High Speed Maglev in the I-70 Corridor

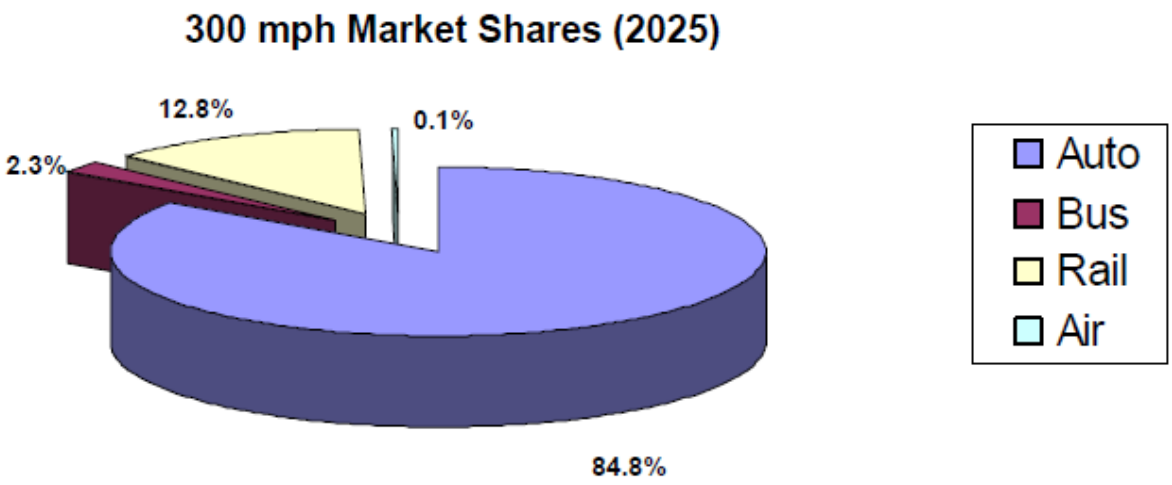


The alignment chosen for the ultra high-speed maglev technology was the I-70 highway right of way alignment developed as part of the I-70 Mountain Corridor Programmatic Environmental Impact Statement (PEIS). It includes a Continental Divide crossing just north and parallel to the Eisenhower-Johnson Memorial Tunnels and spurs to Black Hawk and Central City, Keystone and Breckenridge. This alignment is consistent with the preferred alternative in the I-70 Mountain Corridor PEIS. This alignment is also superior to the four percent grade alignment in station locations, speed and potential ridership.

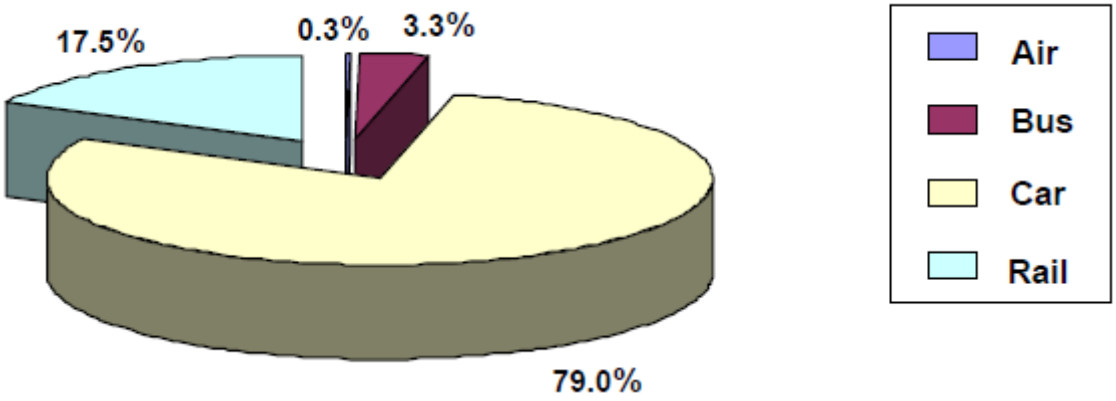
The ultra high-speed maglev technology demonstrates the best operating ratio (2.44) of any of the alternatives evaluated in the RMRA study. This is in part due to the lower operating and maintenance costs for a maglev system over conventional rail systems and in part due to the better average speeds and shorter travel times, which boost ridership and fare revenues.

Ridership

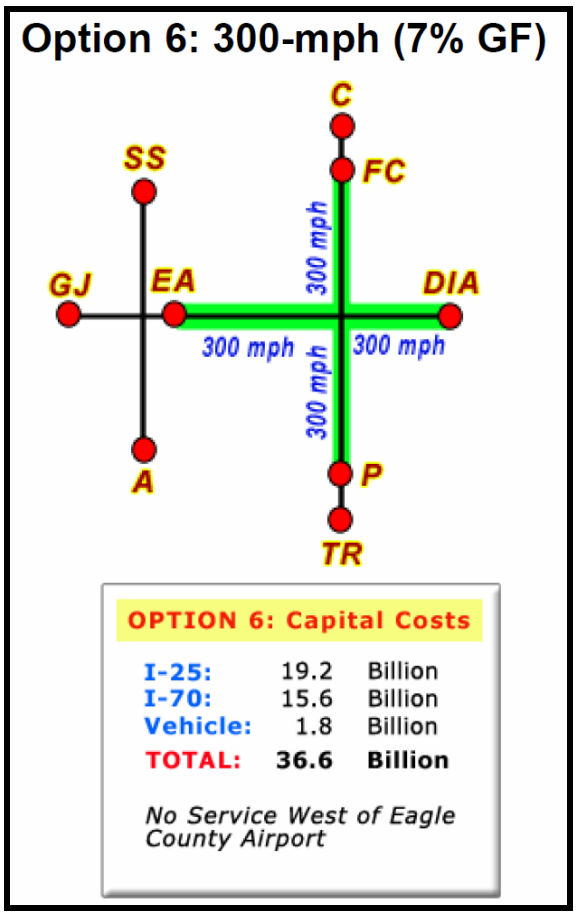
For the 300 mph, maglev technology, in 2025 with a Low Gas Price (from the Energy Information Administration) and the Central Demographic projections for Colorado, the Ridership Market Share as a percentage of overall intercity trips in both the I-25 and I-70 corridors is 12.8 percent. This is well above Intercity Bus which is projected to be 2.3 percent with this intercity passenger rail alternative.

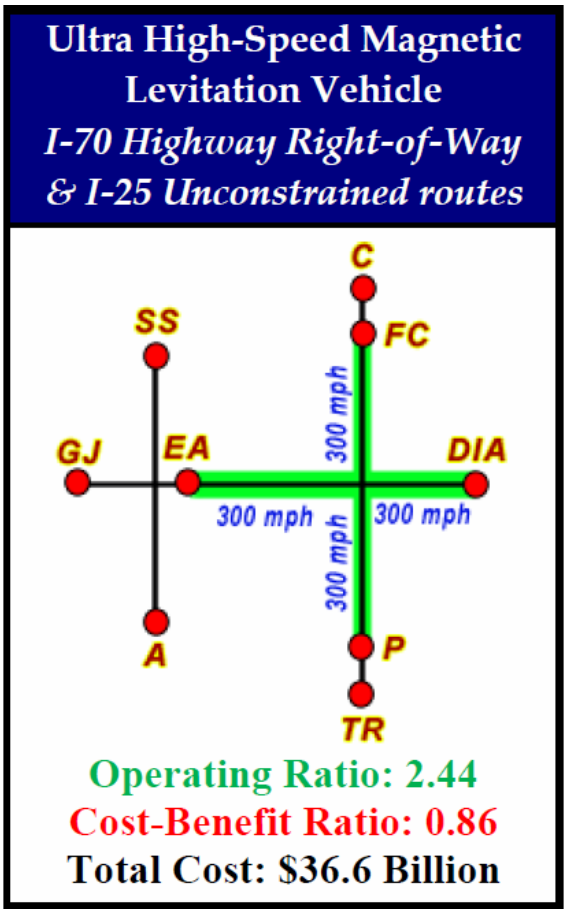


In 2035 with Central Gas Prices (from the Energy Information Administration) the Ridership Market Share as a percentage of overall trips in both the I-25 and I-70 corridors is 17.5 percent. This is much higher than Intercity Bus which is projected to be 3.3 percent with this intercity passenger rail alternative.



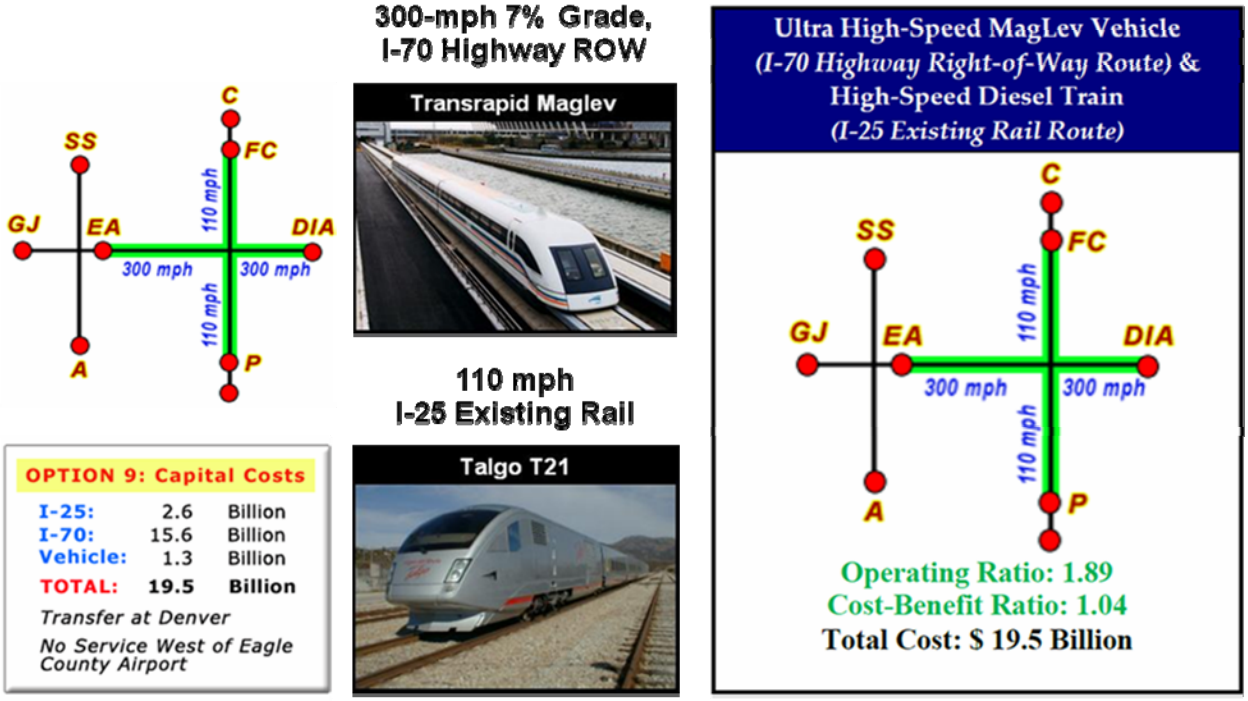
System Termini & Capital Cost





The ultra high-speed maglev technology does not meet the FRA cost to benefit criteria due to the high capital cost in the I-25 corridor compared to at-grade conventional rail. However, an alternative combining the ultra high-speed maglev technology in the I-70 corridor and a conventional rail technology in the I-25 corridor (even a relatively slow 130 mph conventional diesel passenger rail technology in an existing freight railroad right of way alignment) will meet the FRA cost to benefit criteria and produce an operating ratio approaching 1.9. Such an alternative was evaluated in the RMRA Study and the results are captured below.

Results of 300 mph Ultra High Speed Maglev in the I-70 Corridor combined with 130 mph Tilting, Lightweight Diesel Passenger Rail in the I-25 Corridor



There was not time and budget allocated in the RMRA Study to evaluate a combination alternative with the ultra high-speed maglev technology in the I-70 corridor and the 220 mph tilting EMU technology in the I-25 corridor. However it is anticipated that such an alternative would produce operating ratio numbers above 2.0 and cost to benefit numbers above the 1.04 from the combination alternative captured above. The full evaluation of this type of combination alternative has great potential as the next step for Colorado in the pursuit of a viable and cost-effective high-speed intercity passenger system with popular support.

Conclusion

The 300 mph ultra high-speed maglev alternative is the only RMRA study alternative consistent with the Advanced Guideway System which is the central component of the preferred alternative in the I-70 Programmatic Environmental Impact Statement process. As a completely elevated system, it is the safest mode possible with zero potential conflicts with freight trains or cars and trucks on roadways. It will also produce much less noise than conventional high-speed rail vehicles and will have a much smaller environmental footprint than at-grade conventional high-speed rail systems. It is also faster, accelerates and decelerates quicker and has lower operational and maintenance costs than conventional high-speed rail systems. It produces superior operating ratio numbers as a result.

Unfortunately, this alternative (even combined with a conventional rail alternative in the I-25 corridor) was never seriously considered as the “preferred” or “FRA Developed” alternative in the RMRA study. Current Federal Railroad Administration (FRA) policies favor low-speed conventional passenger rail technologies sharing freight railroad infrastructure and using at-grade crossings. And since the FRA is the federal agency responsible for providing funding for HSR development in the United States, the RMRA study catered to a

FRA friendly result. The RMRA study consultant believed that FRA policy was paramount in conducting the feasibility study, regardless of the results of the I-70 PEIS process and the well known desires of the I-70 mountain corridor jurisdictions for a safe, advanced, dedicated guideway, elevated monorail or maglev system.

From the I-70 Mountain Corridor Revised Draft Programmatic Environmental Impact Statement, September 2010, page 2-43 and 2-44:

Advanced Guideway System– The Advanced Guideway System is a central part of the Preferred Alternative and includes the commitment by the lead agencies to evaluate and implement an Advanced Guideway System within the Corridor including a vision of transit connectivity beyond the study area and local accessibility to such a system. At this Tier 1 level, the Advanced Guideway System represents a mode encompassing a range of technologies, not a specific technology. A specific Advanced Guideway System technology would be determined in subsequent study or a Tier 2 document. The Colorado Department of Transportation commits to provide funding for studies to determine the viability, including cost and benefits, safety, reliability, environmental impacts, technology, and other considerations of an Advanced Guideway System. These studies will involve the Collaborative Effort stakeholder committee and follow the I-70 Mountain Corridor Context Sensitive Solutions process.

The Advanced Guideway System provides transit service from the Eagle County Regional Airport to C-470, a distance of approximately 118 miles. The Advanced Guideway System is a fully elevated transit system on two tracks and aligns to the north, south, or in the median of I-70.

The Advanced Guideway System connects to the Regional Transportation District network in Jefferson County and local and regional transit services at most of the 15 proposed transit stations along the route.

The Advanced Guideway System requires new tunnel bores at both the Eisenhower-Johnson Memorial Tunnels and the Twin Tunnels. At the Eisenhower-Johnson Memorial Tunnels, the proposed third tunnel bore would be located to the north of the existing tunnel bores and accommodate a bidirectional Advanced Guideway System. At the Twin Tunnels, the proposed third tunnel bore would be located to the south of the existing tunnel bores and accommodate a bidirectional Advanced Guideway System.

The I-70 PEIS is an 11 year National Environmental Policy Agency regulated (NEPA) process conducted by the Colorado Department of Transportation in conjunction with the Federal Highway Administration. The I-70 PEIS process has collaborated with stakeholders from all over Colorado over its 11 year study history.

The I-70 PEIS process as a NEPA regulated study has convened larger scoping and outreach efforts, and greater public and stakeholder engagement and participation than the RMRA study. This is not discounting the RMRA study; however as a first step HSR feasibility study, the RMRA study had just a fraction of I-70 PEIS budget.

While the RMRA study consultant utilized the data developed in the I-70 PEIS process, they often ignored its conclusions on the grounds that it was a Federal Highway Administration (FHWA) sanctioned study and not a Federal Railroad Administration (FRA) sanctioned study.

As Chairman of the RMRA 52 local government organization throughout the RMRA study process, I found the study consultant's almost religious dedication to outdated and potentially irrelevant FRA policy guidelines over the will of the people of Colorado (as demonstrated through the I-70 PEIS NEPA process) to be completely absurd.

The FRA has completely different policy guidelines for the evaluation and selection of alternatives than the FHWA. The FRA and the RMRA study consultant did not understand the Context Sensitive Solutions process developed by the FHWA which mandates stakeholder involvement and collaboration in the development and selection of alternatives in NEPA regulated studies. This is a federal process that actually works and produces preferred and selected alternatives that blend into their affected environments and are well accepted by all stakeholders because they were created as a direct result of effective collaboration. The FHWA is light years ahead of the FRA in this regard and it is about time the FRA was dragged kicking and screaming into the 21st century.

Throughout the RMRA study process, the FRA appeared beyond reproach in their arrogance as the single and dominant federal "expert" agency on the determination of feasibility for intercity passenger rail alternatives in United States. Their consistent policy and preference for funding low-speed, fare subsidized, conventional heavy diesel intercity passenger rail in freight railroad corridors including at-grade crossings and often sharing track with freight trains, appeared beyond reproach. It was as if the FRA and their outdated policies had grown larger and more important than the people of this country and their elected officials, who are suppose to manage and direct federal agencies such as the FRA. The FRA and their ridiculous HSR policies appeared accountable to no one and the RMRA study consultant adhered blindly to these absurd policy guidelines.

The FRA has and continues to demonstrate a complete lack of interest in any relatively new, safe, high-speed passenger rail technology and any high-speed rail technology operating in safe, specialized and dedicated guideways, well separated from existing freight railroad tracks and completely grade separated from roadways. They have forgotten that with the construction of the Interstate Highway System, America has grown in and along highway corridors over the past 50 years and not in and around freight railroad corridors. The places Americans want to travel to and from today are in highway corridors, not freight railroad corridors.

Until recently, the FRA has been relatively insignificant in most state's transportation planning processes, since most states primary transportation focus has been on roadway and aviation systems. Instead of engaging the real experts who plan the dominant transportation modes in this country today (highways and aviation) in order to develop a sound and progressive national high-speed passenger rail program, the FRA arrogantly relied on their outdated Amtrak policies and practices and released the world's most regressive national high-speed rail plan focusing primarily on low-speed, fare subsidized, conventional heavy diesel intercity passenger rail in freight railroad corridors, including at-grade crossings and often sharing track with freight trains. Instead of delivering advanced technology and bullet trains in safe, dedicated and completely grade separated guideways, the FRA is delivering glorified Amtrak – and proud of it. Sooner or later, Americans are going to realize that their government is spending billions of dollars on low-speed intercity passenger rail systems that on a relative basis, no one will ride.

Regardless of the decisions already made by a parallel federal agency in the I-70 PEIS process, the FRA and the RMRA study consultant following FRA guidelines demonstrated very little interest in advanced maglev technologies and alignments outside of existing

freight railroad rights of way. For this reason, an impractical and unachievable 4 percent grade alignment in the I-70 mountain corridor and conventional very high-speed tilting EMU technology was selected as the “FRA Developed” alternative in the RMRA study, directly in conflict with the study findings of the I-70 PEIS process.

From day one of the RMRA study I heard from many RMRA jurisdictions and stakeholders that freight railroad rights of way would not work for high-speed rail in Colorado, especially after the difficulties the RTD experienced in negotiating access with the freight railroads for their Fastracks Corridors. But our consultant wasn’t listening. Only after having been beat up for over a year and effectively completing the study, did the RMRA study consultant concede that highway and Greenfield alignments would provide equal or better alternatives for the state of Colorado.

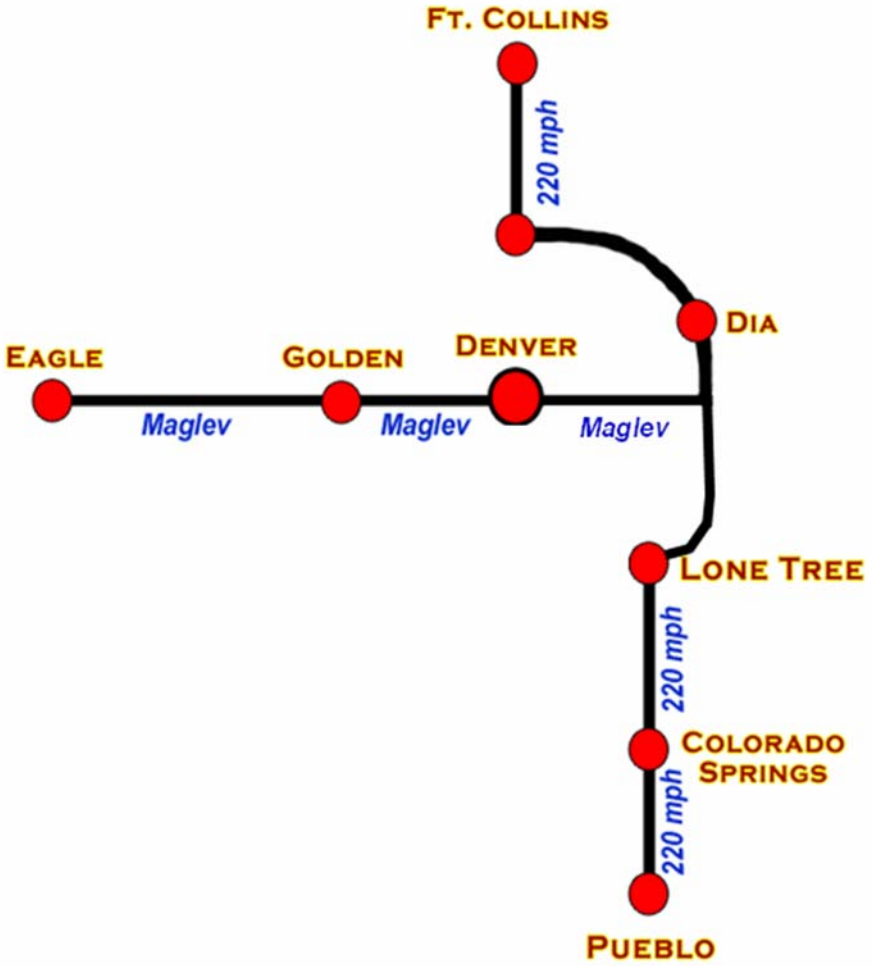
The RMRA had to pay for additional analysis to evaluate a potential E-470 alignment to avoid freight railroad right of way through Denver and the results were fairly positive with improved travel times both north and south of Denver into DIA and better ridership numbers overall.

So regardless of outdated FRA policy, their remains great potential in Colorado for advanced technology and bullet trains in safe, dedicated and completely grade separated guideways that follow highway corridors, not freight railroad corridors.

Next Step Alternative

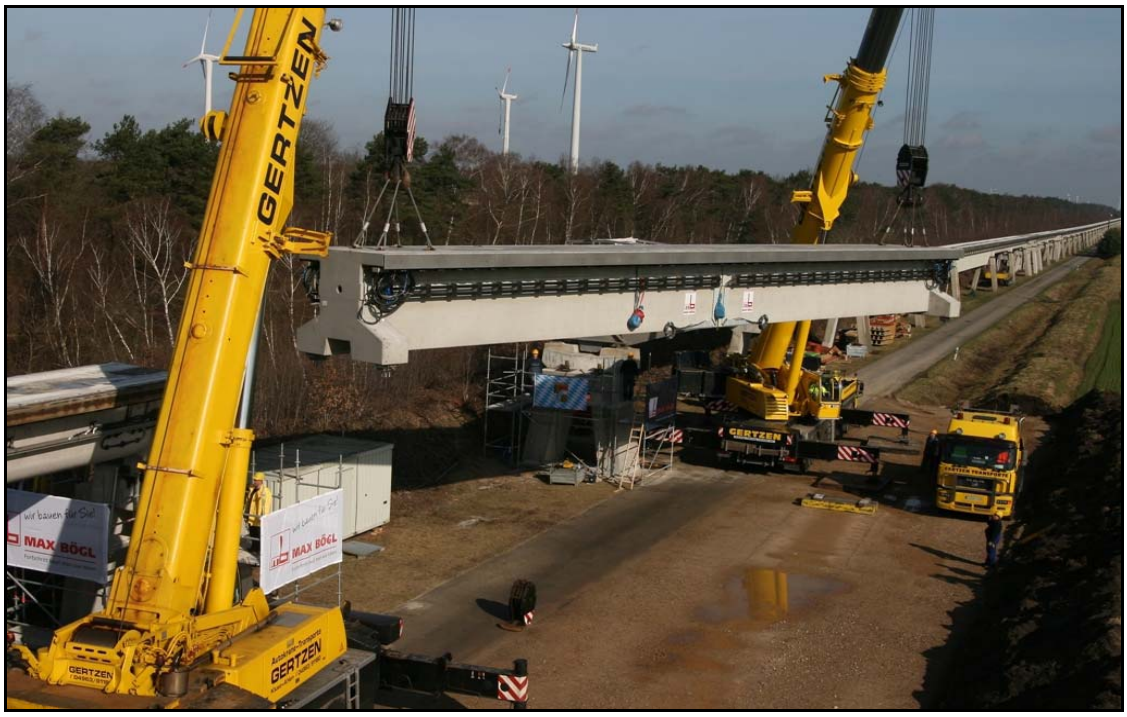
The next step alternative for Colorado based on the findings of the RMRA study needs to be a hybrid alternative using the ultra high-speed maglev technology in the I-70 corridor from DIA to Eagle County Airport and the very high-speed tilting electric EMU technology in a dedicated alignment along the I-25 highway and the E-470 highway with some Greenfield locations east of I-25 from fort Collins to Pueblo. The data developed in the RMRA study would suggest that such an alternative would prove highly feasible and have excellent operating ratio numbers and good support from around the state of Colorado.

Next Step HSR Alternative for Colorado



In addition, modular, prefabricated guideway sections have been recently developed for the construction of the ultra high-speed maglev system and have the potential to reduce guideway construction costs by up to 30 percent. Consideration of these construction cost savings could make a complete I-70/I-25 corridor maglev system capital cost competitive with a conventional high-speed rail system.

Prefabricated and prewired guideway sections set in place in under three hours



Rocky Mountain Rail Authority

Top Three Activities for the Next Three Years

Completion of a Colorado State Rail Plan

A State Rail Plan articulates the existing and future role of freight and passenger rail within a state's multimodal transportation system. Colorado's state rail plan will take stock of current and needed rail assets throughout the state and establish a vision for both freight and passenger rail service with a 2040 horizon and provide a clear path to implementing improvements.

This is the starting point to begin planning freight and passenger rail improvements on a statewide level and integrating them into the multimodal statewide transportation improvement process. It is also a necessary first step for Federal Railroad Administration funding eligibility for the funding of future rail projects.

An appropriate Colorado passenger rail vision might be to allow a visitor to fly into DIA and connect conveniently through an integrated passenger rail system to the popular business and resort destinations in both the I-70 and I-25 corridors. Likewise, I-70 and I-25 corridor travelers would be able to travel conveniently throughout the state on an integrated passenger rail system to DIA, Downtown Denver and the other popular business and resort destinations in both the I-70 and I-25 corridors.

The State Rail Plan is the beginning of the development of a long term vision for an integrated passenger rail system in Colorado that bridges urban, regional and intercity passenger rail systems to connect the popular business and resort destinations in both the I-70 and I-25 corridors.

Our visionary objective should be to provide a fast, competitive, convenient and energy efficient alternative to driving that will diversify Colorado's surface transportation infrastructure and allow Colorado to compete successfully in an unpredictable future global economic climate likely to be influenced by Peak Oil and Climate Change.

Support for RTD FasTracks and other Urban and Rural Transit System Development throughout Colorado

The critical first step for high speed intercity passenger rail is the development of our urban and rural local public transit systems. The number of local trips on a daily basis far outweighs the number of intercity and longer distance trips. Local public transit systems in addition to facilitating local trips can be the springboard for connectivity to longer distance passenger rail systems.

Successful public transportation infrastructure required to develop a functional and competitive, statewide and even interstate integrated system works in layers to accommodate urban, local, regional, intercity and interstate trips. As a high speed passenger rail advocate, it is critical to understand the need for the development of local public transportation infrastructure to accommodate local trips and provide the base layer of

public transit infrastructure that is necessary to build a larger integrated statewide public transit system.

As urban public transit systems expand and make urban trips more accessible, convenient and competitive with driving; connecting urban systems on a regional and intercity basis through a high speed intercity passenger rail network becomes the next logical progression to create an integrated statewide public transit system.

Completion of an I-70 Mountain Corridor Advanced Guideway System Feasibility Study

The I-70 Mountain Corridor Programmatic Environmental Impact Statement process will conclude in 2011 with a Tier 1 Record of Decision that contains an Advanced Fixed Guideway System transit component from Golden to Eagle County Airport. This alternative was developed between 2001 and 2004 using vehicle performance and overall system data from the FTA Urban Maglev Research Program.

Since 2004, there have been many improvements in maglev technology. There are today functioning maglev systems in revenue producing service in different parts of the world that were not available for evaluation in 2004 when the I-70 Mountain Corridor alternative research took place. Further research for maglev technology application in the I-70 mountain corridor is necessary in order to advance a final solution. A definitive feasibility study needs to be conducted as a follow up to the work completed in both the I-70 Mountain Corridor Programmatic Environmental Impact Statement and the Rocky Mountain Rail Authority High Speed Rail Feasibility Study that looks specifically at the feasibility of currently operating maglev technologies around the world today in a 7 percent highway alignment in the I-70 mountain corridor.

This feasibility study is supported by the I-70 PEIS Collaborative Effort group convened by CDOT to help develop the preferred alternative in the I-70 PEIS process as the next logical step for the development of the mountain corridor transit component and has been prioritized by the I-70 Coalition as an appropriate next step after the Record of Decision expected in 2011.

Competitive True High Speed Long Distance Intercity and Interstate Maglev Model

- Fast, non fare subsidized, average speeds well above 100 mph, typically at least twice as fast as automobile travel and at least half as fast as commercial air travel
- Lightweight, wide, high technology, energy efficient, non buff strength compliant vehicles
- Ultra-fast acceleration, high cruising speeds (up to 300 mph) and extraordinarily safe travel at high speeds
- Ultra-reliable all-weather operation, extremely quiet and zero vibration
- High technology, high speed, low noise appeal induces ridership
- Very safe, unique, completely dedicated and grade separated high speed guideway that does not conflict with freight trains, automobiles or trucks
- Guideway infrastructure that requires little maintenance over its 80 year life cycle
- Elimination of at-grade crossings

- Extremely high schedule reliability due to dedicated guideway and lack of conflicts with freight trains, automobiles and trucks
- Market driven fare structure that considers the value of time in people's transportation decisions and charges an appropriate price for very competitive travel time compared with automobile and commercial air travel
- Higher speeds, lower maintenance and dramatically lower life cycle costs result in a greatly accelerated rate of return to investors and an operating profit, instead of loss
- Elimination of large annual operating subsidies
- Fifteen to twenty percent (or higher) annual average ridership percentages based on total person-trips in a specified transportation corridor
- No freight trains displaced to trucks and roadways, because high speed maglev trains do not use freight railroad tracks
- Freight railroad tracks and right of way are reserved for their most valuable use, the movement of goods to meet current and future US freight demand